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(54) OPTICAL ELEMENT AND METHOD FOR PRODUCING THE SAME

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an optical element which can reversibly control the degree of reflection or the presence of reflection by applying an electric field and ensures a much lower operating voltage than a conventional one formed with a multilayer structure of a liquid crystal and a polymerized and cured substance and to provide a method for producing the optical element.

SOLUTION: The optical element whose refractive index varies periodically has a multilayer structure comprising (A) a liquid-crystalline material and a polymerized and cured substance of a polymerizable composition containing (B) a polymerizable compound containing a (meth)acrylate having a 5-25C alkyl group in a side chain and (C) a photopolymerization initiator between two transparent substrates with respective electrode layers. In the multilayer structure, the liquid-crystalline material and the polymerized and cured substance are alternately laminated and the alternately formed layers are different from one another in the contents of the liquid-crystalline material and the polymerized and cured substance.

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CLAIMS

[Claim(s)]
[Claim 1] It consists of a polymerization hardened material of the polymerization nature constituent containing (A) liquid crystal ingredient between two transparent substrates which have an electrode layer, the polymerization nature compound containing the acrylate which has the alkyl group of the (B) carbon numbers 5-25 in a side chain (meta), and (C) photopolymerization initiator. The optical element from which the content of the liquid crystal ingredient of a layer and a polymerization hardened material which took the multilayer structure which a liquid crystal ingredient and the polymerization hardened material of a polymerization nature constituent repeat by turns, and was formed by turns differs by the layer and from which a refractive index changes periodically.
[Claim 2] (A) The optical element according to claim 1 in which the liquid crystal ingredient contains the liquid crystal which has a cyano group at a tolan frame or the end.
[Claim 3] The optical element according to claim 1 or 2 in which a polymerization nature constituent contains monofunctional (meta) acrylate further.
[Claim 4] The optical element according to claim 1, 2, or 3 characterized by forming the liquid crystal ingredient among layers with many contents of a liquid crystal ingredient including the drop let condition which is covered with a polymer and exists independently.
[Claim 5] The optical element of any one publication of claim 1-4 whose optical element is a reflective mold optical element.
[Claim 6] The optical element of any one publication of claim 1-4 whose optical element is a transparency mold optical element.
[Claim 7] The optical element of any one publication of claim 1-6 which changed spacing of the layer which mainly consists of a liquid crystal ingredient, and the layer which mainly consists of a polymerization hardened material for every pixel electrode.
[Claim 8] (A) liquid crystal ingredient between two transparent substrates which have an electrode layer, the polymerization nature compound containing the acrylate which has the alkyl group of the (B) carbon numbers 5-25 in a side chain (meta), and the polymerization nature constituent containing (C) photopolymerization initiator The manufacture approach of an optical element that the content of the liquid crystal ingredient of the layer which took the multilayer structure which a liquid crystal ingredient and a polymerization hardened material repeat by turns, and was formed by turns which carries out a polymerization by interference light exposure, and a polymerization hardened material changes with layers and that a refractive index changes periodically.
[Claim 9] The manufacture approach of an optical element according to claim 8 that a polymerization nature constituent contains monofunctional (meta) acrylate further.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] By impressing electric field etc., this invention penetrates alternatively, reflects the light of the wavelength of ultraviolet, visible, and a near-infrared region, and relates to the optical element or optical display device which can use the light filter and liquid crystal display component which control a reflective degree reversibly further, a liquid crystal modulated light component, etc., and its manufacture approach.
[0002]
[Description of the Prior Art] Conventionally, what vapor-deposited thin films, such as a metal, on glass, and the thing which recorded the interference light on silver salt or a photosensitive ingredient as a display device using a hologram are known as the optical element which penetrates alternatively the light of the wavelength of ultraviolet, visible, and a near-infrared region, and may be reflected, or an optical display device, it is used for an infrared cut filter etc., and the use to a HUD, a high mounting stop lamp, a solid three-dimensional display, etc. is considered further.
[0003] Moreover, an interference fringe is irradiated at the non-hardened material of a photoresist, and the mixture containing liquid crystal, a photo-curing object is stiffened, it has the layer structure from which the refractive index by liquid crystal and the hardened material changes periodically by turns, and the refractive index of liquid crystal is changed by making electric field impress to this, and the optical element which can control a reflective degree and reflective existence reversibly is proposed (for example, JP,4-355424,A etc.).
[0004] However, transparency of specific wavelength and the reflective degree of what vapor-deposited thin films, such as a metal, on glass, the volume hologram optical element using a hologram, or a display device are always fixed, and what can control such reflective degrees and reflective existence reversibly was desired further.
[0005] The optical element which consists of multilayer structure of liquid crystal and a polymerization hardened material on the other hand can control a reflective degree reversibly by impressing electric field. However, since the driver voltage is high, it is an obstruction to utilization and a fall of the driver voltage of a component is desired strongly.
[0006]
[Problem(s) to be Solved by the Invention] Therefore, the technical problem which this invention tends to solve is by impressing electric field rather than the optical element in which it was reversibly controllable and the operating voltage was formed by the multilayer structure of the conventional liquid crystal and a polymerization hardened material in a reflective degree or reflective existence to offer the optical element which is a low battery whether you are Haruka, and its manufacture approach.
[0007]
[Means for Solving the Problem] this invention persons came to complete a header and this invention for the above-mentioned technical problem being solvable by using the polymerization nature compound containing the acrylate which has specific structure (meta), as a result of repeating research wholeheartedly.
[0008] Namely, this invention consists of a polymerization hardened material of the polymerization nature constituent containing (A) liquid crystal ingredient between two transparent substrates which

have (1) electrode layer, the polymerization nature compound containing the acrylate which has the alkyl group of the (B) carbon numbers 5-25 in a side chain (meta), and (C) photopolymerization initiator. The optical element from which the content of the liquid crystal ingredient of a layer and a polymerization hardened material which took the multilayer structure which a liquid crystal ingredient and the polymerization hardened material of a polymerization nature constituent repeat by turns, and was formed by turns differs by the layer and from which a refractive index changes periodically, and [0009] (2) An optical element given in (1) in which (A) liquid crystal ingredient contains the liquid crystal which has a cyano group at a tolan frame or the end, and [0010] (3) An optical element given in (1) in which a polymerization nature constituent contains monofunctional (meta) acrylate further, or (2), and [0011] (4) An optical element given in (1) characterized by forming the liquid crystal ingredient among layers with many contents of a liquid crystal ingredient including the drop let condition which is covered with a polymer and exists independently, (2), or (3), and [0012] (5) The optical element of any one publication of (1) - (4) whose optical element is a reflective mold optical element, and [0013] (6) The optical element of any one publication of (1) - (4) whose optical element is a transparency mold optical element, and [0014] (7) The optical element of any one publication of (1) - (6) which changed spacing of the layer which mainly consists of a liquid crystal ingredient, and the layer which mainly consists of a polymerization hardened material for every pixel electrode, and [0015] (8) (A) liquid crystal ingredient between two transparent substrates which have an electrode layer, the polymerization nature compound containing the acrylate which has the alkyl group of the (B) carbon numbers 5-25 in a side chain (meta), and the polymerization nature constituent containing (C) photopolymerization initiator The manufacture approach of an optical element that the content of the liquid crystal ingredient of the layer which took the multilayer structure which a liquid crystal ingredient and a polymerization hardened material repeat by turns, and was formed by turns which carries out a polymerization by interference light exposure, and a polymerization hardened material changes with layers and that a refractive index changes periodically, and [0016] (9) A polymerization nature constituent includes the manufacture approach of the optical element a publication in (8) which contains monofunctional (meta) acrylate further.

[0017]

[Embodiment of the Invention] To the transparent substrate which has an electrode layer, the multilayer structure repeated by turns [of the liquid crystal ingredient in this invention and a polymerization hardened material] may be parallel, and may incline at an angle of specification. To the transparent substrate side which has an electrode layer, when near in parallel, it becomes the optical element of a reflective mold, and the multilayer structure repeated by turns [of a liquid crystal ingredient and a polymerization hardened material] serves as an optical element of a transparency mold, when perpendicularly near.

[0018] Among the light which carried out incidence of the case of the optical element of a reflective mold to the optical element, it reflects and most light in which others carried out incidence penetrates only specific wavelength and the light of a wavelength region. The spectrum of the light which carried out incidence of the case of the optical element of a transparency mold to the optical element is carried out, and it is penetrated and reflected.

[0019] An example of the cross section of the optical element of the reflective mold manufactured by drawing 1 by this invention is shown. In drawing 1 , 1 shows a transparency substrate, 2 shows a transparency electrode, 3 shows a layer with many contents of liquid crystal, and 4 shows a layer with many contents of a polymerization hardened material. An example of the cross section of the optical element of the transparency mold manufactured by drawing 2 by this invention is shown. In drawing 2 , 1 shows a transparency substrate, 2 shows a transparency electrode, 3 shows a layer with many contents of liquid crystal, and 4 shows a layer with many contents of a polymerization hardened material.

[0020] A liquid crystal ingredient is covered with a polymer and the layer with many contents of the liquid crystal of three in drawing 1 and drawing 2 shows structure including the drop let condition which exists independently, or the structure which the liquid crystal ingredient opened for free passage.

[0021] A liquid-crystal ingredient is covered with a polymer, the structure which exists

independently in the state of drop let, or a liquid-crystal ingredient is covered with a polymer, and structure including the drop let condition which a liquid-crystal ingredient is covered with a polymer and exists independently expresses the structure where of the structure which exists independently in the state of drop let, and the structure where of a liquid crystal ingredient is open for free passage to some extent, and exists are intermingled.

[0022] A liquid crystal ingredient is covered with a polymer, and with the rate of polymerization of a polymerization nature compound, or the ratio of a liquid crystal ingredient, the layer with many contents of the liquid crystal of 3 shows structure including the drop let condition which exists independently, or shows with them the structure which the liquid crystal ingredient opened for free passage. A liquid crystal ingredient is covered with a polymer, and the driver voltage of an optical element shows the inclination which becomes high, so that there are many rates of the drop let condition of liquid crystal in the case of structure including the drop let condition which exists independently. Therefore, since structure with few drop let conditions of liquid crystal becomes low [driver voltage], it is desirable.

[0023] An example of the concrete manufacture approach of the optical element of the reflective mold of this invention is shown in drawing 3 . The transparency cel 9 using two transparency substrates with an electrode is formed, and the polymerization nature constituent containing (A) liquid crystal ingredient, (B) polymerization nature compound, and (C) photopolymerization initiator of this invention is made to intervene in the cel in drawing 3 . With the beam expander 6, extend the diameter of an optical axis for coherent light, such as laser light from 5Ar laser, and it is made to dichotomize by the beam splitter 7, and irradiate the aforementioned constituent from a 2-way using a mirror 8 etc., two light is made to interfere, an interference light is produced, and this interference light is irradiated.

[0024] As for the bright part of an interference light, the solubility of the liquid crystal of the bright part of an interference light decreases by that cause by the polymerization of a polymerization nature compound advancing preferentially, and liquid crystal is discharged from the bright part of an interference light, and forms a layer with many contents of a polymerization hardened material. On the other hand, the polymerization of a polymerization nature compound does not advance, but the liquid crystal discharged from the part with a still brighter interference light is added, and the dark part of an interference light forms a layer with many contents of liquid crystal. The optical element in which the multilayer structure from which the refractive index of a layer with many contents of the liquid crystal of three in drawing 1 and a layer with many contents of the polymerization hardened material of 4 changes periodically by turns by this was formed is obtained.

[0025] The refractive index of a layer with many contents of liquid crystal becomes higher than the refractive index of a layer with many contents of a polymerization hardened material. According to the difference of such two refractive indexes of the multilayer structure of a layer, the Bragg diffraction shown by the formula (1) arises, and the light of specific wavelength is reflected among the light which carried out incidence to the optical element.

[0026] Formula (1)

2dSINtheta=nlambda (among a formula, in d, the Bragg angle and lambda express the wavelength of the reflected light, and, as for n, spacing of the center to center of a layer with many contents of liquid crystal and a layer with many contents of a polymerization hardened material and theta express a degree)

[0027] The wavelength of light reflected is determined by spacing of the center to center of a layer with many contents of liquid crystal, and a layer with many contents of a polymerization hardened material with the Bragg's equation shown by the formula (1). If spacing of the center to center of a layer with many contents of the liquid crystal formed into an optical element and a layer with many contents of a polymerization hardened material is fixed to reflect only the light of specific wavelength, it will become possible to reflect only specific wavelength.

[0028] Moreover, what is necessary is just to form the interlayer spacing of a layer with many contents of liquid crystal, and a layer with many contents of a polymerization hardened material so that the light of the wavelength region may start diffraction when reflecting the light of a certain wavelength region. If the reflection factor of the specific wavelength by the reflective mold optical element of this invention puts in another way the difference and the number of repeats of layer

structures of the refractive index of a layer with many contents of liquid crystal, and a layer with many contents of a polymerization hardened material, it will be determined by the thickness of the whole multilayer structure, and a reflection factor becomes large, so that the thickness of the whole multilayer structure is thick.

[0029] Moreover, since a reflection factor becomes high, it is so desirable that the difference of the refractive index of a layer with many contents of liquid crystal and a layer with many contents of a polymerization hardened material is large to enlarge the difference of the refractive index of a layer with many contents of liquid crystal and a layer with many contents of a polymerization hardened material. Therefore, if it will be made thin if the thickness of the multilayer structure by the layer with many contents of liquid crystal and the layer with many contents of a polymerization hardened material has the large difference of a refractive index, and the difference of a refractive index is small and it will thicken, the same reflection factor will be obtained.

[0030] However, when changing a reflection factor reversibly with an electrical potential difference etc. and the thickness of the whole multilayer structure is thick, there is a trouble that driver voltage becomes high. Therefore, it is desirable to enlarge the difference of the refractive index of a layer with many contents of liquid crystal and a layer with many contents of a polymerization hardened material, and to make thickness thin, and the thickness of the whole multilayer structure has desirable 2-50 micrometers.

[0031] In order to control a reflective degree and reflective existence reversibly, electric field, a field, etc. are impressed to a component and it becomes possible by changing the refractive index of the liquid crystal in a component by changing continuously the difference of the refractive index of a layer with many contents of the liquid crystal of 3 in drawing 1 or drawing 2 , and a layer with many contents of the polymerization hardened material of 4.

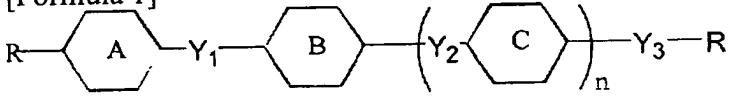
[0032] Liquid crystal carries out orientation of the time of electrical-potential-difference impression in the direction of electric field, and in order that the difference of the refractive index of a layer with many contents of liquid crystal and the refractive index of a layer with many contents of a polymerization hardened material may decrease, a reflection factor decreases. By controlling the electrical potential difference to impress, it is possible to control the reflection factor of specific wavelength continuously.

[0033] In the case of the component of a reflective mold, it becomes possible by seting constant spacing of a layer with many contents of liquid crystal, and a layer with many contents of a polymerization hardened material, and forming an electrode for every pixel to display a monochromatic alphabetic character and a monochromatic picture. Moreover, it becomes possible without using a color filter etc. by forming in spacing which produces the reflected light corresponding to three colors of RGB for a layer with many contents of liquid crystal, and a layer with many contents of a polymerization hardened material for every pixel electrode to perform color display.

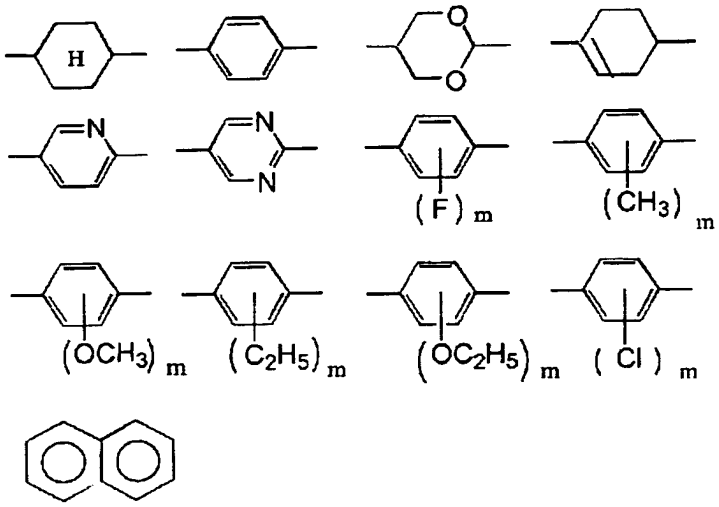
[0034] As an approach of forming in spacing which produces the reflected light corresponding to three colors of RGB for a layer with many contents of liquid crystal, and a layer with many contents of a polymerization hardened material for every pixel electrode For example, it is made to intervene with a liquid crystal ingredient, a polymerization nature compound, and a photopolymerization initiator between two transparent substrates which have an electrode layer, a protection-from-light mask is formed in the part of two colors of green and blue among three colors of RGB, and the interference light used as the interlayer spacing which makes only a red part produce reflection of red is irradiated. The protection-from-light mask of a part green next is removed, and the interference light used as the interlayer spacing which produces green reflection is irradiated. Finally the protection-from-light mask of a blue part is removed, and the interference light used as the interlayer spacing which produces blue reflection is irradiated.

[0035] Since the optical element of this invention consists of liquid crystal and a polymerization hardened material compared with the volume hologram optical element by conventional resin, the refractive-index difference between layers can be enlarged and diffraction efficiency serves as a high optical element. Moreover, the manufacture approach of this invention does not need a special ingredient which is used for the usual volume hologram, but after hardening, since it is necessary to remove a specific ingredient or and it does not need to infiltrate other ingredients like the

international public presentation No. 10926 [91 to], productivity is good [the approach].
[0036] The substrate used by this invention may be a strong ingredient, for example, glass etc., and may be the ingredient which has flexibility, for example, the thing like plastic film. Two substrates may separate suitable spacing face to face. Moreover, they have transparency and must carry out vision of the multilayer structure pinched between the two sheets from the external world. However, perfect transparency is not made indispensable.
[0037] According to the purpose, a transparent electrode may be arranged on that whole surface or a partial target at this substrate. Moreover, the active-matrix substrate which prepared active elements, such as a thin film transistor (TFT), a thin-film diode, and a metallic insulator metal nonlinear resistance component (MIM), for every pixel electrode may be used.
[0038] In order to control the thickness of the whole multilayer structure which consists of liquid crystal and a polymerization hardened material, the spacer for spacing may be made to intervene like the liquid crystal device of well-known common use between two substrates. You may mix in the solution containing a liquid crystal ingredient and a polymerization hardened material, and a spacer may be applied on a substrate.
[0039] As these spacers, the thing for various liquid crystal cells, such as a Mylar, an alumina, rod type glass fiber, a glass bead, and a polymer bead, can use it without a limit especially, for example.
[0040] Of course, it does not require that the liquid crystal ingredient (A) used by this invention is a single liquid crystallinity compound. It aims at improving solubility with the property of a liquid crystal ingredient, i.e., the phase transition temperature of an isotropic liquid and liquid crystal, the melting point, viscosity, delta n and delta epsilon, a polymerization nature compound, etc. You may be two or more sorts of liquid crystal compounds, and the optical element after manufacture should just be the liquid crystal which can acquire a good property that what is necessary is just what can choose and blend suitably, can use and is usually recognized as a liquid crystal ingredient by this technical field.
[0041] As a liquid crystal ingredient (A) used by this invention, a nematic liquid crystal, a smectic liquid crystal, cholesteric liquid crystal, etc. are desirable, and especially a nematic liquid crystal is desirable. Moreover, in order to improve the engine performance, chiral compounds, such as cholesteric-liquid-crystal, chiral nematic liquid crystal, and chiral smectic liquid crystal, etc. may be contained.
[0042] As these liquid crystal ingredients (A), they are general formulas (2), such as a benzoate system, a cyclohexane-carboxylic-acid ester system, a biphenyl system, a terphenyl system, a phenylcyclohexane acid system, a pyrimidine system, a pyridine system, a dioxane system, a cyclohexane cyclohexane ester system, a tolan system, an alkenyl system, a fluoro system, cyano **, and a naphthalene system.
[0043]
[Formula 1]



[0044] (Respectively, in independent, the inside of a formula and Rings A, B, and C express one which is shown in ** 2 of rings, and are [0045].)
[Formula 2]



[0046] The integer of 0-2 and m n the integer of 1-4, and Y1 and Y2 In independent, respectively Single bond, -CH2CH2-, -CH2O-, -COO-, OCO-, -C**C-, -CH=CH-, -CF=CF-, -(-CH2)4-, -CH2CH2CH2O-, or -CH2=CHCH2- is expressed. - Y3 expressing single bond, -COO-, or -OCO-, R expresses a hydrogen atom, a halogen atom, a cyano group, the alkyl group of the carbon atomic numbers 1-20, an alkoxy group, an alkenyl radical, an alkenyloxy radical, a fluoro alkyl group, and a fluoro alkoxy group in independent.

[0047] It can come out and the liquid crystal compound expressed can be used. It is desirable to use the liquid crystal ingredient which especially contains tolan system liquid crystal and cyano liquid crystal especially.

[0048] The principal chain structure of the acrylate which has the alkyl group of carbon numbers 5-25 in a side chain among the polymerization nature compounds (B) containing the acrylate which has the alkyl group of the carbon numbers 5-25 used by this invention in a side chain (meta) (meta) is not limited especially that what is necessary is just the structure where it is used as usual acrylate. Moreover, one is sufficient as the number of side chain radicals to acrylate 1 molecule which has the alkyl group of carbon numbers 5-25 in a side chain (meta), and it may be plural.

[0049] Although the number of the functional groups in one molecule of the acrylate which has the alkyl group of carbon numbers 5-25 in a side chain (meta) does not limit especially the number, when making quick the rate of polymerization of a liquid crystal ingredient, a polymerization nature compound, and the polymerization nature constituent that consists of a photopolymerization initiator that what is necessary is just two or more, the optical element after manufacture should just choose it the appearance which can acquire a good property, and timely that what is necessary is just to make [many] the number of functional groups.

[0050] (B) In the range which does not spoil the effectiveness of this invention, the polymerization nature compound containing the acrylate which has the alkyl group of carbon numbers 5-25 in a side chain (meta) may use together other polymerization nature compounds, for example, di(meth) acrylate, and can also contain the monofunctional (meta) acrylate of well-known common use further. Although the polymerization nature compound (B) containing the acrylate which has the alkyl group of carbon numbers 5-25 in a side chain (meta) may be a uniform solution and may be uneven, the thing used as a uniform solution is desirable. Moreover, it is possible to mix with liquid crystal in the state of un-hardening, and, as for the mixture mixed with liquid crystal, what becomes a homogeneity solution is desirable.

[0051] As a (C) photopolymerization initiator used by this invention, it is 2-hydroxy, for example. - It is 2-methyl-1-phenyl propane-1-ON ("DAROKYUA 1173" by Merck Co.), 1-hydroxy cyclohexyl phenyl ketone (the "IRUGA cure 184" by Ciba-Geigy), 1-(4? isopropyl phenyl)-2-hydroxy-isobutane-1-ON ("DAROKYUA 1116" by Merck Co.), and [0052]. Benzyl dimethyl ketal (the "IRUGA cure 651" by Ciba-Geigy), The 2-methyl-1-[4-(methylthio) phenyl]-2-morpholino propanone -1 (the "IRUGA cure 907" by Ciba-Geigy), 2, the mixture of 4-diethyl thioxan ton (the "kaya cure DETX" by Nippon Kayaku Co., Ltd.), and p-dimethylamino ethyl benzoate (the "kaya cure EPA" by Nippon Kayaku Co., Ltd.), The mixture of an isopropyl thioxan ton ("can TAKYUA

ITX" by the WORD PUREKIN soup company) and p-dimethylamino ethyl benzoate etc. is mentioned.
[0053] The operating rate of (A) liquid crystal ingredient in a polymerization nature constituent has 30 - 80% of desirable range, the operating rate of (B) polymerization nature compound has 19 - 69% of desirable range, and the operating rate of (C) photopolymerization initiator has 1 - 20% of desirable range.
[0054] As an energy line for polymerizations, formation of an interference light is possible and a coherent light is [that what is necessary is just to be able to carry out the polymerization of said polymerization nature constituent] specifically spatially [in time / laser light etc. / and] desirable. Although the exposure reinforcement and the exposure of an interference light need the strength and amount more than fixed, they are influenced by the reactivity of a polymerization nature constituent and the class of photopolymerization initiator, and concentration. Therefore, what is necessary is just to choose the exposure reinforcement optimal timely and the exposure optimal timely.
[0055]
[Example] The example of this invention is shown below and this invention is explained to a detail. However, this invention is not limited to these examples. Moreover, as long as there is no notice especially in the following examples,"%", "% of the weight" is expressed and each of an evaluation property means the following notations and contents.
[0056] The reinforcement of ultraviolet rays was measured using the uni-meter "UIT-101" by USHIO, INC., and a photo detector "UVD-365PD." Using the spectrometer U-3500 (Hitachi, Ltd. make), measurement of a reflection factor measured the permeability of a sample and made reduction of the permeability by reflection the reflection factor.
[0057] ROFF: Applied voltage (Vrms), lambda from which the reflection factor when making reflection-factor (%) Vr90:ROFF at the time of no electrical-potential-difference impressing into 100%, and making a reflection factor when an electrical potential difference is impressed and reduction in a reflection factor is saturated into 0% becomes 10%: Main wavelength of the reflected light (nm)
[0058] 54% (Dainippon Ink & Chemicals, Inc. make) of liquid crystal ingredients which have a tolan frame, (Example 1) 2 and the number of alkyls of a side chain radical Acrylate (Dainippon Ink & Chemicals synthetic compounds) 38% of 7 [a principal chain frame] [the number of ECH denaturation 1,6-hexanediol diacrylate and side chain radicals] And the polymerization nature constituent which consists of "C101" (Toagosei make) 8% as a polymerization initiator was poured in between the glass cells with an ITO electrode of two sheets of about 11 micrometers of cel thickness, and the whole substrate was held at about 25 degrees C.
[0059] After considering as the parallel ray whose diameter of an optical axis is about 10mm by the beam expander and making it the two flux of lights using a beam splitter, using an argon laser (wavelength ultraviolet-rays about 800 W/m2 of 363.8mm on the strength) as the light source for exposure, by irradiating the polymerization constituent in a glass cell from a 2-way, the interference light was irradiated for 300 seconds and the optical element was obtained. As a result of measuring many properties of this optical element, it was ROFF=14(%) Vr90=50Vrms and lambda= 460 (nm).
[0060] 54% (Dainippon Ink & Chemicals, Inc. make) of liquid crystal ingredients which have a tolan frame, (Example 2) The number of the alkyls of 2 and a side chain radical Acrylate (Dainippon Ink & Chemicals synthetic compounds) 33% of 7 [a principal chain frame] [the number of ECH denaturation 1,6-hexanediol diacrylate and side chain radicals] The polymerization nature constituent which consists of "C101" (Toagosei make) 8% as laurylacrylate (**** fats-and-oils company make) 5% and a polymerization initiator was poured in between the glass cells with an ITO electrode of two sheets of about 11 micrometers of cel thickness, and the whole substrate was held at about 25 degrees C.
[0061] After considering as the parallel ray whose diameter of an optical axis is about 10mm by the beam expander and making it the two flux of lights using a beam splitter, using an argon laser (wavelength of 363.8mm, ultraviolet-rays about 800 W/m2 on the strength) as the light source for exposure, by irradiating the polymerization constituent in a glass cell from a 2-way, the interference light was irradiated for 300 seconds and the optical element was obtained. As a result of measuring many properties of this optical element, it was ROFF=13(%) Vr90=41Vrms and lambda= 460 (nm).

[0062] 54% (Dainippon Ink & Chemicals, Inc. make) of liquid crystal ingredients which have a tolan frame, (Example 3) The number of the alkyls of 2 and a side chain radical Acrylate (Dainippon Ink & Chemicals synthetic compounds) 38% of 18 [a principal chain frame] [the number of ECH denaturation 1,6-hexanediol diacrylate and side chain radicals] And the polymerization nature constituent which consists of "C101" (Toagosei make) 8% as a polymerization initiator was poured in between the glass cells with an ITO electrode of two sheets of about 11 micrometers of cel thickness, and the whole substrate was held at about 25 degrees C.
[0063] After considering as the parallel ray whose diameter of an optical axis is about 10mm by the beam expander and making it the two flux of lights using a beam splitter, using an argon laser (wavelength of 363.8mm, ultraviolet-rays about 800 W/m2 on the strength) as the light source for exposure, by irradiating the polymerization constituent in a glass cell from a 2-way, the interference light was irradiated for 300 seconds and the optical element was obtained. As a result of measuring many properties of this optical element, it was ROFF=16(%) Vr90=20Vrms and lambda= 460 (nm).
[0064] (Example 4) Cyano liquid crystal RO571 (Dainippon Ink & Chemicals, Inc. make) 54%, The number of the alkyls of 2 and a side chain radical Acrylate (Dainippon Ink & Chemicals synthetic compounds) 38% of 7 [a principal chain frame] [the number of ECH denaturation 1,6-hexanediol diacrylate and side chain radicals] And the polymerization nature constituent which consists of "C101" (Toagosei make) 8% as a polymerization initiator was poured in between the glass cells with an ITO electrode of two sheets of about 11 micrometers of cel thickness, and the whole substrate was held at about 25 degrees C.
[0065] After considering as the parallel ray whose diameter of an optical axis is about 10mm by the beam expander and making it the two flux of lights using a beam splitter, using an argon laser (wavelength of 363.8mm, ultraviolet-rays about 800 W/m2 on the strength) as the light source for exposure, by irradiating the polymerization constituent in a glass cell from a 2-way, the interference light was irradiated for 300 seconds and the optical element was obtained. As a result of measuring many properties of this optical element, it was ROFF=13(%) Vr90=62Vrms and lambda= 460 (nm).
[0066] (Example 5) The same polymerization nature constituent as an example 1 was poured in between the glass cells with an ITO electrode of two sheets of about 11 micrometers of cel thickness, and the whole substrate was held at about 25 degrees C. After considering as the parallel ray whose diameter of an optical axis is about 10mm by the beam expander and making it the two flux of lights using a beam splitter, using an argon laser (wavelength of 363.8mm, ultraviolet-rays about 800 W/m2 on the strength) as the light source for exposure, by changing the crossed axes angle of the two flux of lights in an example 1, and irradiating the polymerization constituent in a glass cell from a 2-way, the interference light was irradiated for 300 seconds and the optical element was obtained. As a result of measuring many properties of this optical element, it was ROFF=14(%) Vr90=48Vrms and lambda= 530 (nm).
[0067] (Example 6) The same polymerization nature constituent as an example 1 was poured in between the glass cells with an ITO electrode of two sheets of about 11 micrometers of cel thickness, and the whole substrate was held at about 25 degrees C. The mask was formed in the appearance by which an interference light is irradiated by only the part of the arbitration of a cel. After considering as the parallel ray whose diameter of an optical axis is about 10mm by the beam expander and making it the two flux of lights using a beam splitter, using an argon laser (wavelength of 363.8mm, ultraviolet-rays about 800 W/m2 on the strength) as the light source for exposure, the interference light was irradiated for 300 seconds by irradiating the crossed axes angle of the two flux of lights from a 2-way like an example 1 at the polymerization constituent in a glass cell.
[0068] Next, the mask was changed, the mask was installed in the appearance by which an interference light is irradiated by only the part of arbitration of the non-polymerization part of a cel, and the interference light as well as an example 4 was irradiated to the crossed axes angle of the two flux of lights for 300 seconds. Furthermore, the mask was **(ed), irradiated the interference light which changed the crossed axes angle of the two flux of lights for 300 seconds, and obtained the optical element. This optical element had the part which reflects a red light, the part which reflects a blue light, and the part which reflects a green light by the difference among exposure conditions.
[0069] 54% (Dainippon Ink & Chemicals, Inc. make) of liquid crystal ingredients which have a tolan frame, (Example 1 of a comparison) The number of the alkyls of 2 and a side chain radical consists

[a principal chain frame / the number of ECH denaturation 1,6-hexanediol diacrylate and side chain radicals] of "C101" (Toagosei make) 8% as acrylate (Dainippon Ink & Chemicals synthetic compounds) 38% of 3, and a polymerization initiator. The polymerization nature constituent was poured in between the glass cells with an ITO electrode of two sheets of about 11 micrometers of cel thickness, and the whole substrate was held at about 25 degrees C.

[0070] After considering as the parallel ray whose diameter of an optical axis is about 10mm by the beam expander and making it the two flux of lights using a beam splitter, using an argon laser (wavelength of 363.8mm, ultraviolet-rays about 800 W/m2 on the strength) as the light source for exposure, by irradiating the crossed axes angle of the two flux of lights from a 2-way like an example 1 at the polymerization constituent in a glass cell, the interference light was irradiated for 300 seconds and the optical element was obtained. As a result of measuring many properties of this optical element, it was ROFF=5(%) Vr90=270Vrms and lambda= 460 (nm). As compared with the optical element obtained in the example, driver voltage became a high value and the optical element obtained in the example 1 of a comparison had the low reflection factor.

[0071]

[Effect of the Invention] This invention can offer the optical element which is a low battery whether you are Haruka, and its manufacture approach by impressing electric field rather than the optical element in which it was reversibly controllable and the operating voltage was formed by the multilayer structure of the conventional liquid crystal and a polymerization hardened material in a reflective degree or reflective existence.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the mimetic diagram of the sectional view of the optical element of the reflective mold of this invention.
[Drawing 2] It is the mimetic diagram of the sectional view of the optical element of the transparency mold of this invention.
[Drawing 3] It is the mimetic diagram showing an example of the optical exposure approach in manufacture of the optical element of the reflective mold of this invention.
[Description of Notations]
1: Transparency substrate
2: Transparency electrode
3: A layer with many contents of liquid crystal
4: A layer with many contents of a polymerization hardened material
5: Ar laser
6: Beam expander
7: Beam splitter
8: Mirror
9: Transparency cel

[Translation done.]

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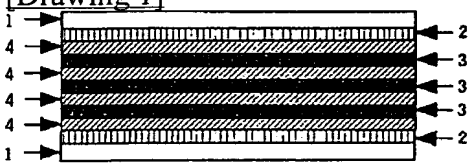
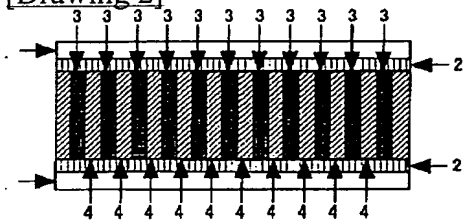
DRAWINGS

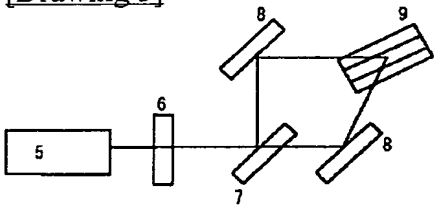
[Drawing 1]



[Drawing 2]



[Drawing 3]



[Translation done.]